AUDIO SYSTEMS

DELPHI AUTOMOTIVE SYSTEMS CORPORATION

Keyword 2000 to RS-232 Gateway

Systems Analysis INterface Tool (SAINT)

Users Guide

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Revision Log

Revision A

    Draft 1 – March 12, 2003

        Initial release of the document.

    Draft 2 – April 25, 2003

        Updated Section 4.4.1 (added message 2C 06 XX message)

    Draft 3 – May 8, 2003

        Changed all references of ACP to Keyword 2000.

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        Updated Section 4.4.1 (added new commands – 07 thru 0A)

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        Updated Section 4.4.1 (added new commands 0B and 0C)

        Updated Section 4.4.1 (changed 500ms to 5000ms on P3 Timeout)

        Updated Section 4.4.1 (changed 2C 01 to show Timeout/Error instead of just Error)

    Draft 6 – January 20, 2004

        Updated Section 4.4.1 (added new commands 0D and 0E)

1   Introduction

1.1   Scope

This document describes the use and operation of SAINT Gateway with Keyword 2000 firmware. This document is proprietary to Delphi Automotive Systems Corporation and cannot be copied in whole or in part without the express written consent of Delphi Automotive Systems Corporation.

1.2   Precedence

This document shall have precedence over any information in any other document. Between reference documents, the document with the later revision date shall have precedence.

1.3   Definitions and Nomenclature

Gateway - abbreviation for Keyword 2000 to RS-232 Gateway.

SAINT   - common nickname for the gateway (Systems Analysis INterface Tool).

Host   - The computer which communicates to the gateway via RS-232 or USB.

USB   - Universal Serial Bus

2 Overview

This document describes the operation of the Keyword 2000 to RS-232 Gateway. The gateway is often referred to as the "SAINT gateway" or simply "SAINT".

The following is synopsis of gateway features:

- Allows host system to communicate on Keyword 2000 bus.
- Performs timing, access, arbitration, serialization, and error control.
- Configuration via host to gateway messages.
- LED status indicator array:
  1. Power LED (flashing LED)
  2. Bus Message LED (toggles upon receiving a valid bus message)
  3. Message Trigger LED (toggles upon receiving a specified byte pattern)
- Gateway to host status / error messages.
- Software is easily updated via a flash connector. Will eventually be done through the USB bus.

The following is a synopsis of requirements for use of the gateway:

Connection to power, ground, and busses to be monitored
RS-232 connection to host

3   RS-232 Setup

The gateway uses the following RS-232 parameters:

- 8 Data Bits
- 1 Stop Bit
- No Parity

The gateway supported baud rate: 57600.

Baud Rate
57600

The supported baud rate is sufficient for communicating with the Class2, Keyword, ACP, BEAN, and slower CAN bus's. However, USB connection is recommended for high speed CAN communications.

3.1   Buffering and Flow Control

Whenever the gateway receives a new message from the host, it will set the CTS line until the message can be processed. The host should not send data to the gateway while the CTS line is set. Due to the speed of the gateway processor, it is unlikely that the host will ever see the CTS line set.

The gateway buffers 64 bytes to send to the host. The gateway polls the RS-232 transmitter in the main loop to send data to the host. In some cases, the RS-232 transmit buffer will overflow. This should occur only when receiving CAN or IIC messages at a very fast rate. This will cause an ERc_RSFull error to be generated and the data to be lost

4   Message Format

To minimize latency with the RS-232 link, all data is sent in binary form. The same data format is used to send and receive messages. The gateway supports bi-directional asynchronous communications.

4.1   Data Stream

The host data stream is broken into messages. A message consists of a Message ID and one or more data bytes.

The character FFh is used as an ESCAPE character to indicate the end of messages. There are three cases when an ESCAPE character is received.

If the ESCAPE character is followed immediately by a second ESCAPE character, the following are true:
- The message is not yet complete.
- The pair of ESCAPE characters represents a single byte of message data of value FFh.

If the ESCAPE character is followed immediately by a byte of value 00h, the following are true.
- The message is complete.
- Neither the FFh nor the 00h are part of the message.
- No more messages are ready to be sent.

If the ESCAPE character is followed immediately by of any value other than FFh or 00h, the following are true:
- The message is complete.
- Neither the ESCAPE character nor the character following the ESCAPE character are part of the message.
- The value following the ESCAPE character is the message ID for a new message.

This data stream format was chosen to allow arbitrary long messages (i.e. 4K Class 2 data blocks), to minimize the overhead to two bytes per message during peak traffic, and to immediately recognize the end of a message without having to wait for the next message to start.

After a gateway reset, the gateway will ignore all data until it sees an ESCAPE character. Once it has received a valid EOM, it will recognize the following message.

4.2   Messages IDs

Message IDs are one byte long and have the following general format:

Type (CAN, BEAN, ACP,Class 2, IIC, etc)	Command (Cmd=1)	Tx (1) / Rx (0)	Time Stamp (TS)
Bits 3 - 7	bit 2	bit 1	bit 0

The upper nibble indicates the type of message. The following types are defined:

- Gateway (08)

- Keyword 82 (10h)

- Keyword 71 (18h)

- IIC (20h)

- Keyword 2000 (28h)

- IDB (30)

- ACP (38h)

- E&C (40h)

- J1708 (48h)

- CAN (50h)

- Class2 (60h)

- Class2 Block (68h)

- SPI (70h)

- BEAN1 (90h)

- BEAN2 (98h)

Bits 3 to 7 identify the specific communication bus (i.e., Class 2, CAN bus, etc.). Bit 2 is used to designate a command or setup message when set to 1. Bit 1 is the transmit or receive bit with 1 designating transmit and 0 designating receive. Bit 0 is used to designate the Time Stamp. In general, report messages from the gateway use the same identifiers as commands to the gateway.

4.3 Gateway Messages

4.3.1 Gateway Commands

The SAINT Gateway supports the following commands:

Header	ID	Data	Description
08h	80h	None	Perform Reset
08h	86h	None	Turn Time Stamp Information OFF
08h	87h	None	Turn Time Stamp Information ON
08h	88h	None	Turn Transmit Echo ON
08h	89h	None	Turn Transmit Echo OFF
08h	92	None	Request Software Version
08h	F0h	D1-D12	Enable Gateway Trigger
08h	F1h	None	Disable Gateway Trigger

4.3.1.1 Reset

This command will cause the gateway to do a complete cold start. The gateway will ignore the next message.

4.3.1.2 Time Stamp

This command controls whether a 16 bit time stamp is appended to the end of the bus message reports.

4.3.1.3 Transmit Echo

This command controls whether transmitted messages are echoed back to the host when they are sent. *Echoed back messages will have their transmit bit set.* Currently the transmit echo is disabled.

4.3.1.4 Software Version Request

This command requests the gateway software version (ASCII).

4.3.1.5 Trigger

This command will cause the gateway to toggle the trigger LED upon receiving the specified byte pattern. Up to 12 data bytes may be used. This feature is helpful for triggering an oscilloscope. (Not available with IDB firmware)

4.3.2   Gateway Reports

The gateway will report a Reset whenever one occurs. Most likely causes of reset are power on reset, host commanded reset, or gateway micro watchdog error. The gateway does a cold start on all resets (all information is lost). The gateway will also report error conditions with the Report Error message below. See section 4.3.2.1 for error code definitions.

The gateway will also echo back all system commands.

Header	ID	Description	Data Bytes
08h	80h	Reset Occurred	None
08h	82h	Report Error	1 byte Error Code
08h	86h	Report Time Stamp Information OFF	None
08h	87h	Report Time Stamp Information ON	None
08h	88h	Report Transmit Echo ON	None
08h	F0h	Report Gateway Trigger ON	None
08h	F1h	Report Gateway Trigger OFF	None

4.3.2.1   Gateway Error Codes

Most error codes are related to sending data at the wrong rate (usually too fast).

Code	Description
80h	System - Invalid message ID
81h	System - RS-232 Transmit Buffer Full
82h	System - UART Error (Overrun, etc.)
83h	System – Received message is too long.
84h	System - Have not read previous message

4.4 Keyword 2000 Messages

4.4.1 Keyword 2000 Commands

The following commands may transmitted to the SAINT.

Header	ID	Description	Data Bytes
2Ch	02h	Set Tester Address	1 byte Tester Address (Default – F1h)
2Ch	03h	Set ECU Address	1 byte ECU Address (Default – 11h)
2Ch	04h	Disable/Enable P1 and P2 Error Reporting	1 byte (00 = Disable and 01 = Enable)
2Ch	05h	Disable Force Checksum (Default)	1 byte (00h)
2Ch	05h	Enable Forced Checksum (error generation)	2 bytes (01h then Checksum byte)
2Ch	06h	Disable/Enable Fast Initialization Sequence (Note: Node-to-Node Communication disables Fast Wakeup Pattern and Start Comm message)	1 byte (see below) 00 = Tester-to-Node Communication 01 = Node-to-Node Communication
2Ch	07h	Addressing Mode	1 byte (see below) 00 = Physical Addressing (default) 01 = Functional Addressing
2Ch	08h	Length included in Format Byte	1 byte (see below) 00 = Length not in Format Byte (default) 01 = Length included in Format Byte
2Ch	09h	Set Baud Rate (More Baud rates can be added as needed.)	1 byte (see below) 00 = 10400 Baud (default) 01 = 9600 Baud 02 = 19200 Baud 03 = 38400 Baud 04 = 57600 Baud 05 = 115200 Baud
2Ch	0Ah	Set Low Time of Fast Init Waveform	1 byte (time in msec) Example: 2C 0A 19 * Sets low portion of Fast Init waveform to 25msec. Therefore, high portion will be 50ms – 25ms = 25ms
2Ch	0Bh	Set P3 Minimum and Maximum Time P3 Minimum Default = 55ms P3 Maximum Default = 5120ms	2 bytes (see below) 00 XX (Set P3 min, XX=time in ms) 01 XX (Set P3 max, XX=time*256 in ms)
2Ch	0Ch	Set P4 Minimum Time P4 Minimum Default = 5ms	2 bytes (see below) 00 XX (Set P4 min, XX=time in ms)
2Ch	0Dh	Enable/Disable Start Communications message	1 byte (see below) 00 = Enable Start Comm Msg (default) 01 = Disable Start Comm Msg

2Ch	0Eh	Enable/Disable Forced Format Byte (Error Testing)	00 = Disable forced format byte (default) 01 XX = enable forced format byte (where XX = format byte)

The following commands are reported by the SAINT (without time stamp information).

Header	ID	Description	Data Bytes
2Ch	00h	Fast Wakeup Pattern Detected	None
2Ch	01h	Keyword 2000 Timeout/Error	1 byte (explained below)

Keyword 2000 Timeout/Errors:

Bit 0   P1 Timeout
0   No timeout detected.
1   Inter byte timeout occurred for ECU (time between bytes > 20msec).

Bit 1   P2 Timeout
0   No timeout detected.
1   Timeout occured between Tester and ECU or two ECU responses (> 50msec).

Bit 2   P3 Timeout
0   No timeout detected.
1   Timeout occured between end of ECU response and start of Tester (> 5000msec).

Bit 3   Checksum Error
0   No error detected.
1   Detected a checksum error of a received Keyword 2000 message.

4.4.2   Transmitted Keyword 2000 Messages

The following is the format for sending a Keyword 2000 message:

Header	SID (Service Identification Byte)	*N Data Bytes*
28h	Byte 2	*Bytes 3 ¾ (2+N)*

The above information is used to form the following message which is sent onto the Keyword 2000 bus (with Length Byte <u>not</u> included in the Format Byte):

Format	Target	Source	Length	SID	N Data Bytes	Checksum
Byte 1	Byte2	Byte 3	Byte 4	Byte 5	Bytes 6 — (5+N)	Byte (6+N)

The above information is used to form the following message which is sent onto the Keyword 2000 bus (with Length Byte included in the Format Byte):

Format	Target	Source	SID	N Data Bytes	Checksum
Byte 1	Byte2	Byte 3	Byte 4	Bytes 5 — (6+N)	Byte (5+N)

Also, the SAINT will check to see if the bus is "initialized" and if necessary will send the Fast initialization sequence (transmit Wakeup Pattern of 25msec logic low and 25msec logic high followed by a Start Communications request message 81 11 F1 81 04). Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 5.1.5.3 for more information.

Currently, only the Fast Initialization sequence is supported. Future initialization sequences will be added as needed.

4.4.3 Received Keyword 2000 Messages

The following are the 4 possible formats of a received Keyword 2000 message with time stamp information:

Header	Format	SID	N Data Bytes	Checksum	Time MSB	Time LSB
29h	Byte2	Byte 3	Bytes 4 - (3+N)	Byte 4+N	Byte 5+N	Byte 6+N

Header	Format	Length	SID	N Data Bytes	Checksum	Time MSB	Time LSB
29h	Byte2	Byte 3	Byte 4	Bytes 5 - (4+N)	Byte 5+N	Byte 6+N	Byte 7+N

Header	Format	Target	Source	SID	N Data Bytes	Checksum	Time MSB	Time LSB
29h	Byte2	Byte 3	Byte 4	Byte 5	Bytes 6 - (5+N)	Byte 6+N	Byte 7+N	Byte 8+N

Header	Format	Target	Source	Length	SID	N Data Bytes	Checksum	Time MSB	Time LSB
29h	Byte2	Byte 3	Byte 4	Byte 5	Byte 6	Bytes 7 - (6+N)	Byte 7+N	Byte 8+N	Byte 9+N

4.4.4 Format byte

The format byte contains a 6-bit length information and a 2-bit address mode information.

Bit 7	Bit 6	Address Information
0	0	no address informatio
0	1	exception mode (CARB)
1	0	with address information, physical addressing
1	1	with address information, functional addressing

Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Length
X	X	X	X	X	X	

Define length of message from the Data to Checksum (not included) bytes. A message length of 1 to 63 bytes is possible. If bits 5-0 are zero then the additional length byte is included. Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.1.1 for more information.

4.4.5   Target address byte

This is the target address for the message and is always used together with the source address byte. Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.1.2 for more information.

4.4.6   Source address byte

This is the address of the transmitting device which is a physical address. Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.1.3 for more information.

4.4.7   Length byte

This byte is provided if the length in the header byte (bits 0-5) is set to 0. It allows the user to transmit messages with data fields longer than 63 bytes. With shorter messages it may be omitted. This byte defines the length of a message from the beginning of the data field (SID included) to the checksum byte (not included). Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.1.4 for more information.

4.4.8   Data bytes

The data field may contain up to 255 bytes. The first byte of the data field is the Service Identification Byte. Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.2 for more information.

4.4.9   Checksum byte

The checksum byte inserted at the end of the message block is defined as the simple 8-bit sum series of all bytes in the message, excluding the checksum. Refer to the "Keyword Protocol 2000 Data Link Layer Recommended Practice" section 4.3 for more information.

5   Connectors

The gateway uses two connectors. One connector is for the RS-232 link and is DB9F. The second connector is a DB9M for the CAN bus (low speed, medium speed, and high speed), Class 2 bus, Keyword, power, and ground. The following pin outs are used:

5.1   RS-232 Connector (J3-DB9F)

A straight pass cable should be used to connect the gateway to the host computer.

DE-9s Pin #	Use
2	TX to Host
3	RX from Host
8	CTS
6	DSR
5	GND

5.2   Bus and Power Connector (J4-DB9M)

DE-9p Pin #	Use
1	Ground
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	Keyword 2000
9	12 volt

5.3 Flash programming connector

Note: the long term goal is to Flash using the USB connector.

Connector J2 is used with an external connector – the intended application of this port is the flash programming of a product. The pin out of the connector J2 – flash programming connectior - is as follows:

Pin #	Mnemonic	Use / description
Line up the connector label with the board pin label.	Osc1	External (to SAINT) oscillator
	Osc2	External (to SAINT) oscillator
	Vdd	Already connected to +5V on SAINT board
	Vss	Already grounded

6   LEDs

Four LEDs are used by the gateway. These LEDs are:

LED #	Purpose
4	NC (No Connection)
3	Trig (Toggled on specified message)
2	Pow (SAINT powered up)
1	Bus (Toggles on receiving a Keyword 2000 message byte)

7 Switches

7.1 SW1 Transceiver Switches:

The following is a summary of the dip switches .

SWITCH #	Mnemonic	Purpose
1	NA	NA
2	NA	NA
3	NA	NA
4	NA	NA
5	NA	NA
6	NA	NA
7	NU	Not currently being used
8	NU	Not currently being used

7.2 SW2 Manual Reset:

SW2 is the manual reset switch. Pressing this switch will change an input to the SAINT microprocessor, causing it to start executing the embedded code from some predetermined start state.

8   Software Packages

The following table lists the latest firmware releases for the SAINT board.

Name	Hardware Version	Date	Description
KW2K_10.HEX	1.2 +	03/12/03	Keyword 2000 initial release.